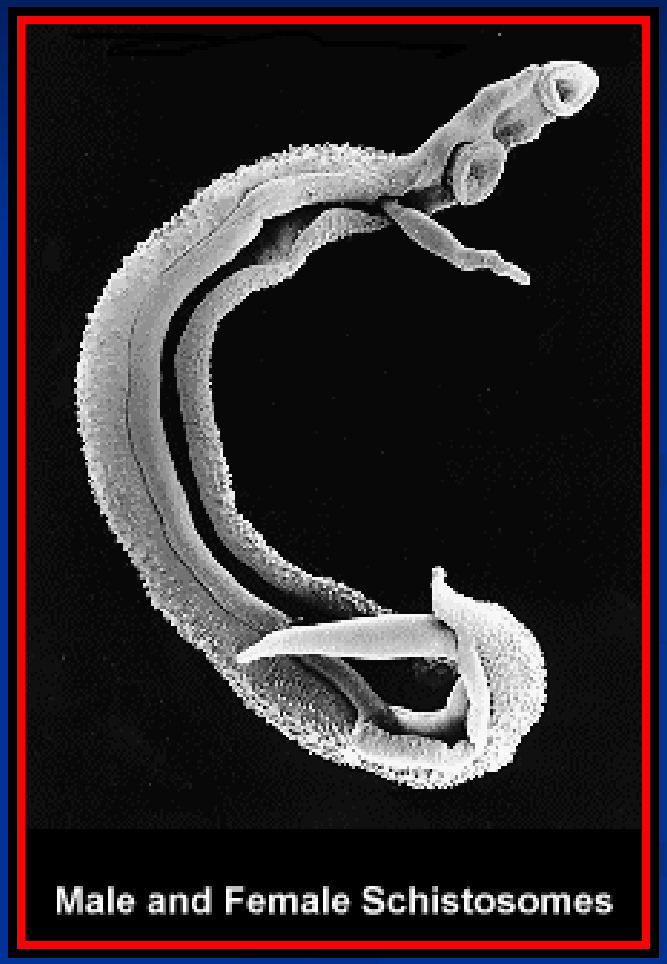
Trematodes

The Flukes

Schistosomiasis



Male and Female Schistosomes

Schistosomes infecting humans

- *Schistosoma mansoni*
- *S. japonicum*
- *S. haematobiun*
- *S. mekongi*
- *S. intercalatum*
- *S. mattheei*
- *S. malayensis*

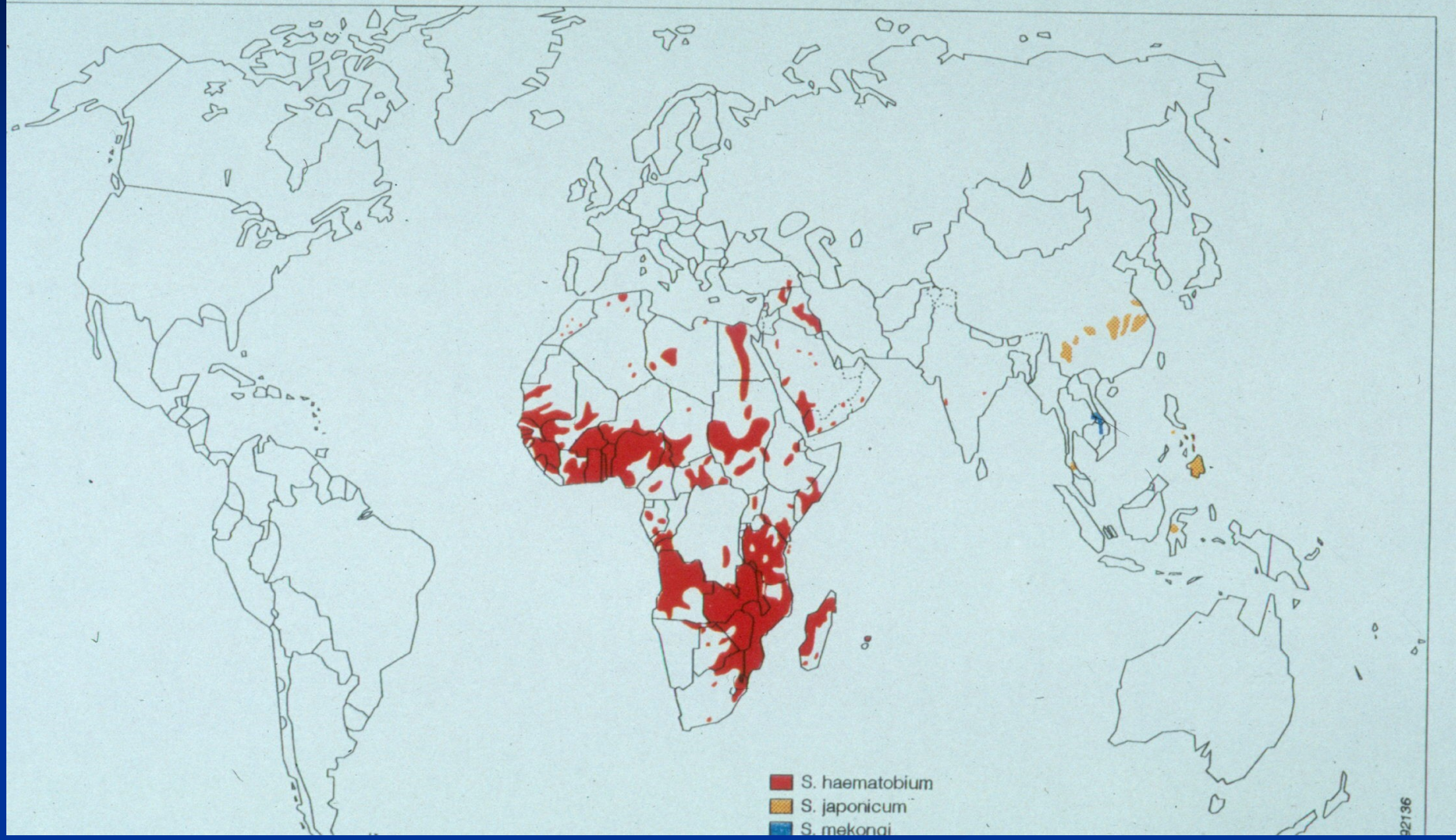
Epidemiology

- 200 million infected in 77 countries
- Transmission from person – snail – person via fresh water
- Acquired via skin penetration by cercariae after release from snail
- Increase in prevalence associated with agricultural development & irrigation, increasing population
- Animal reservoirs important with *S. japonicum*

Geographic Distribution

- *S. mansoni* – Africa, Middle East, Venezuela, Suriname, Brazil, Caribbean
- *S. japonicum* – China, Philippines, Japan, Indonesia
- *S. haematobium* – Middle East, Africa (esp. Nile Delta)
- *S. mekongi* – Mekong Delta
- *S. intercalatum* – West Africa
- *S. mattheei* – Southern Africa
- *S. malayensis* - Malaysia

Fig. 2 Global distribution of schistosomiasis due to Schistosoma haematobium, S. japonicum, and S. mekongi



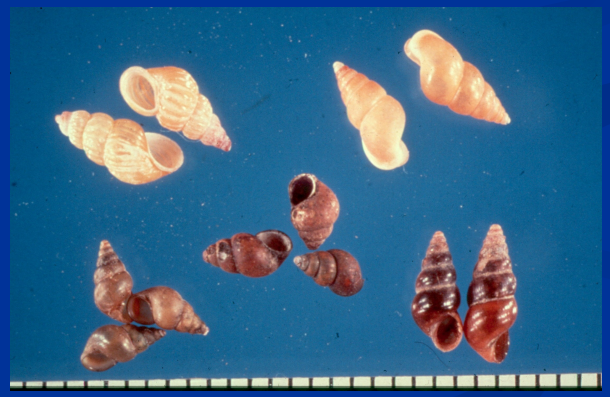
Generalized Life Cycle

- Eggs are shed via feces into water
  - Exception is *S. haematobium* eggs which are shed in urine
- Miracidia hatch & enter snail intermediate hosts
- Develop to actively motile fork-tailed cercariae which exit snail
- Enter human skin & lose tails to become schistosomula

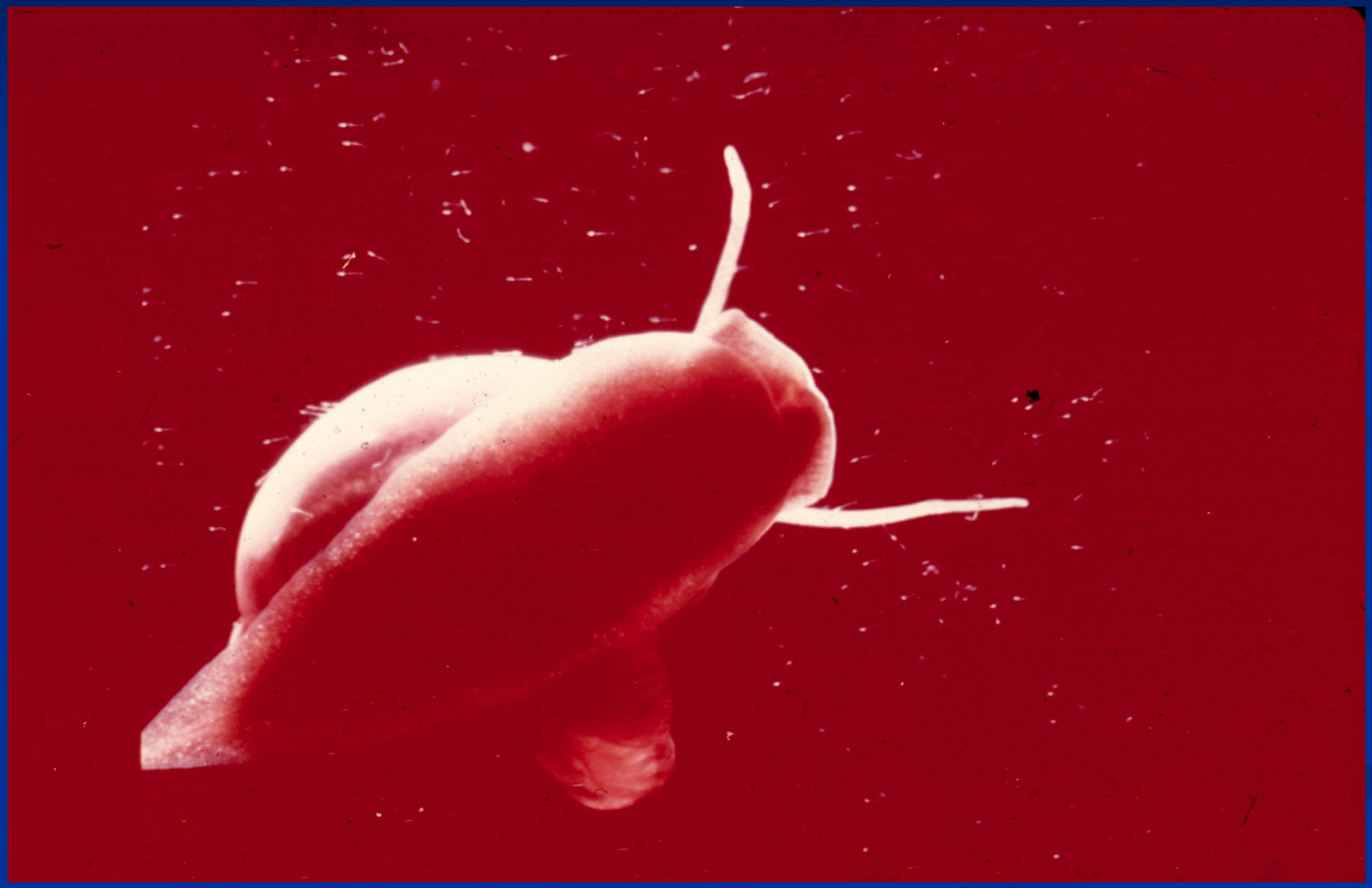
Miracidium emerging from egg

Schistosome intermediate hosts

- Sm – *Biomphalaria* spp. aquatic snails
- Sj – *Oncomelania* spp. amphibious snails
- Sh – *Bulinus* spp. aquatic snails (not shown)



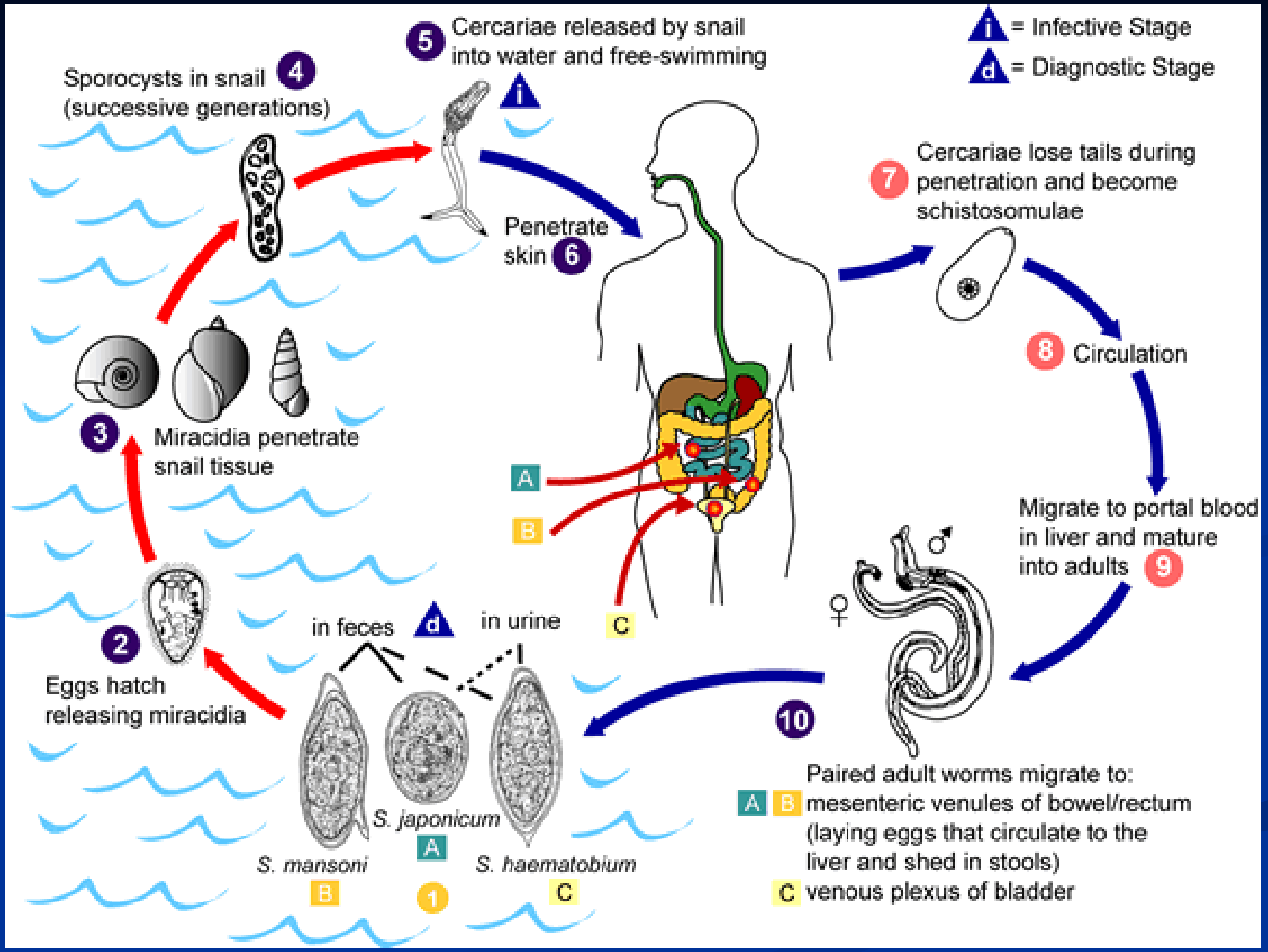
Biomphalaria shedding cercariae



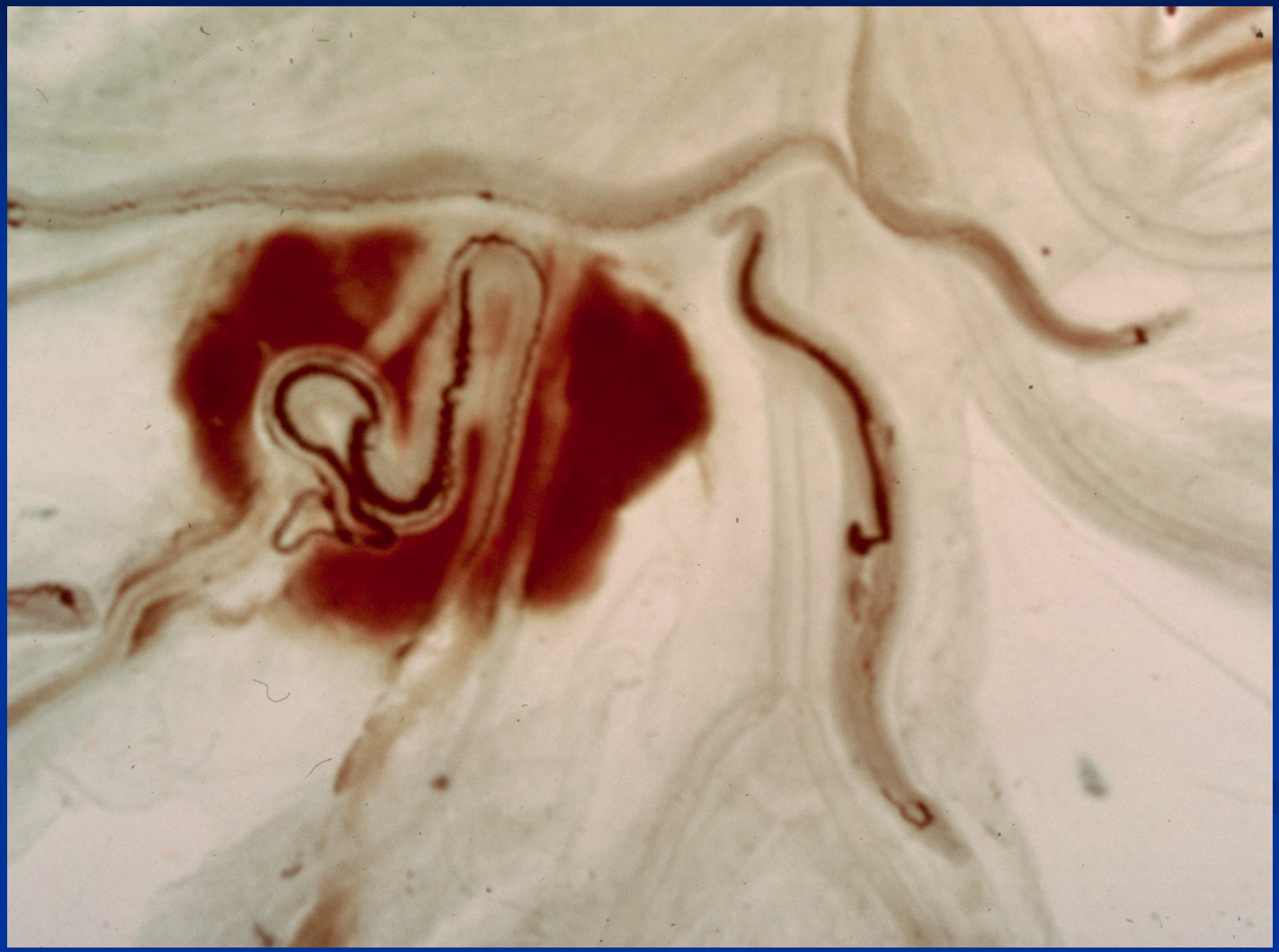
Fork tailed cercaria – enters skin

Life cycle (cont.)

- Migrate via venous blood thru heart & lungs to final habitat, mate
  - Sm – inferior mesenterics
  - Sj – inf. mesenterics & superior hemorrhoidal
  - Sh – vesicular, prostatic, rectal & uterine plexi
- Produce eggs which migrate to intestinal or bladder lumen and exit host
- Paired adults can live many years


i = Infective Stage
d = Diagnostic Stage
1 Cercariae released by snail into water and free-swimming
2 Eggs hatch releasing miracidia
3 Miracidia penetrate snail tissue
4 Sporocysts in snail (successive generations)
5
6 Penetrate skin
7 Cercariae lose tails during penetration and become schistosomulae
8 Circulation
9 Migrate to portal blood in liver and mature into adults
10 Paired adult worms migrate to:
A B mesenteric venules of bowel/rectum (laying eggs that circulate to the liver and shed in stools)
C venous plexus of bladder
in feces
in urine
S. japonicum
S. mansoni
S. haematobium
A
B
C

Paired adults in situ

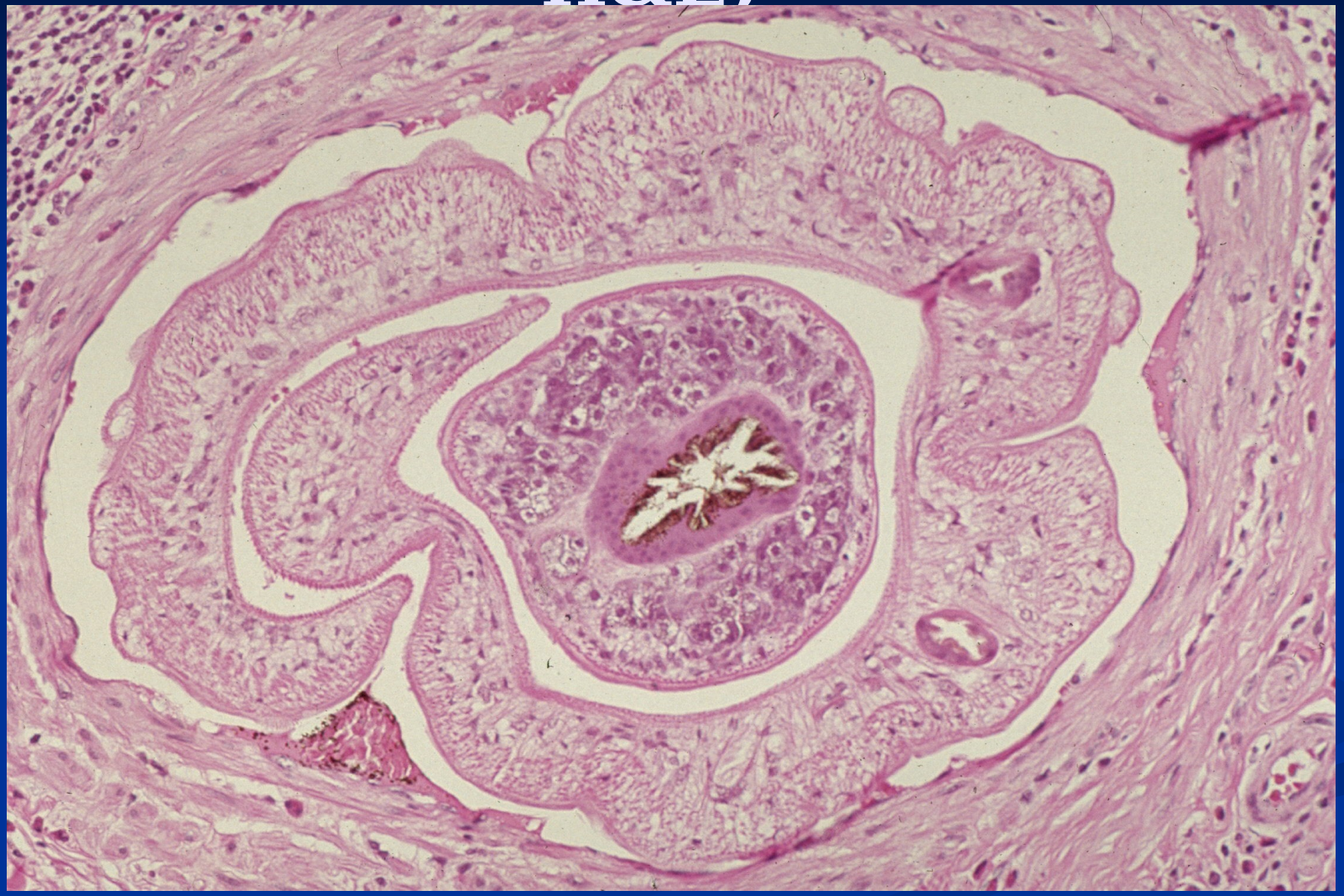


Morphology

- Adults
  - Males 6-12 x 1-1.2 mm, females 7-17 x 0.16 mm
  - Male w/ gynecophoral canal within rests the female
  - Only trematode in humans with separate sexes
- Eggs
  - Embryonated – contain miracidium
  - Only trematode eggs from humans *without* an operculum
  - Have single spine helpful in diagnosis

S. japonicum adults

S. mansoni adults (45x H&E)



Egg Morphology

Species	Size in µm	Spine
S. mansoni	115-175 x 45-70	Large, lateral
S. japonicum	70-100 x 55-65	Small, lateral
S. haematobium	155-170 x 40-70	Large, terminal
S. intercalatum	140-240 x 50-85	Large, terminal
S. mekongi	50-80 x 40-65	Small, lateral

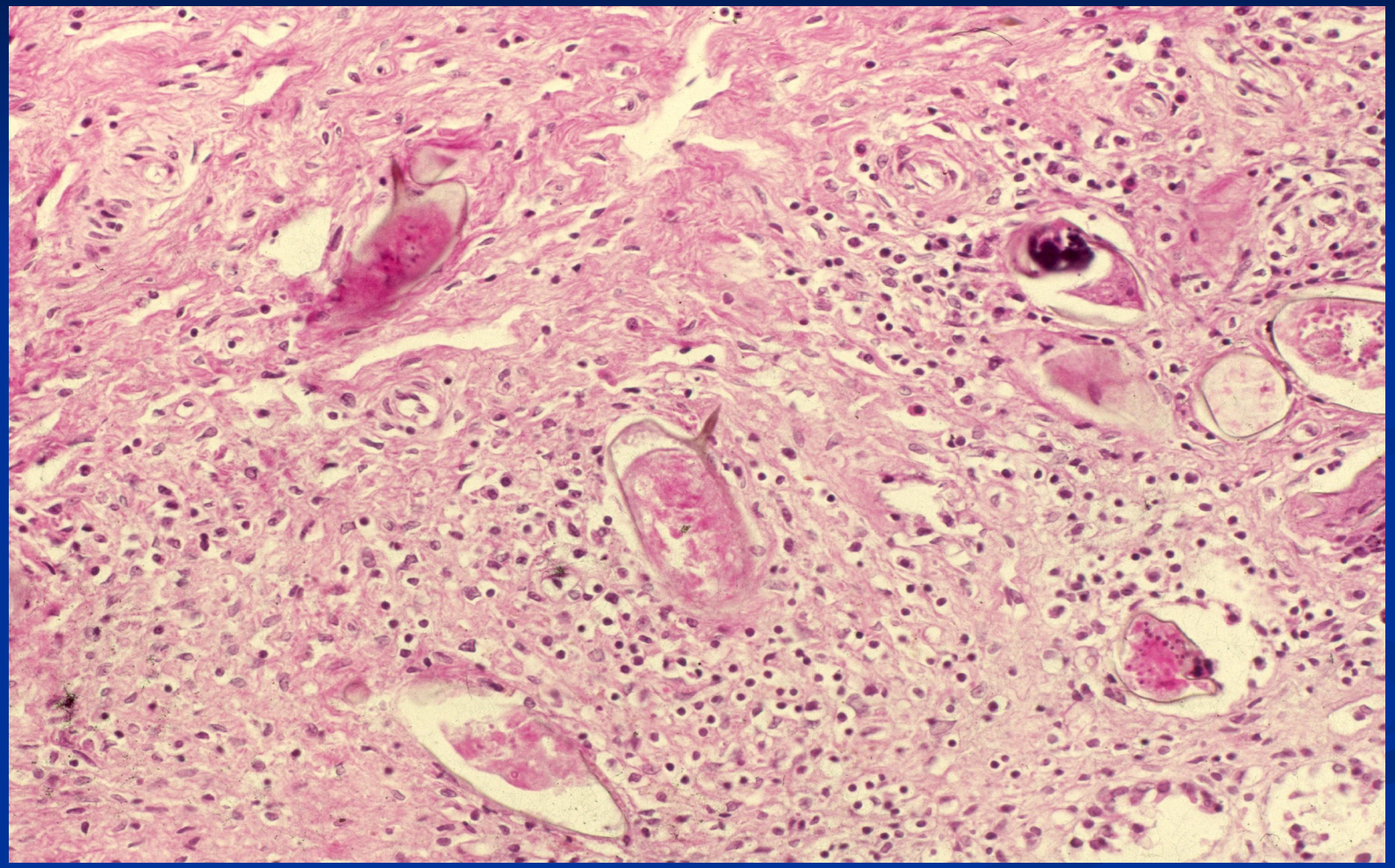
Quiz!! Wooohooo!

Pathology

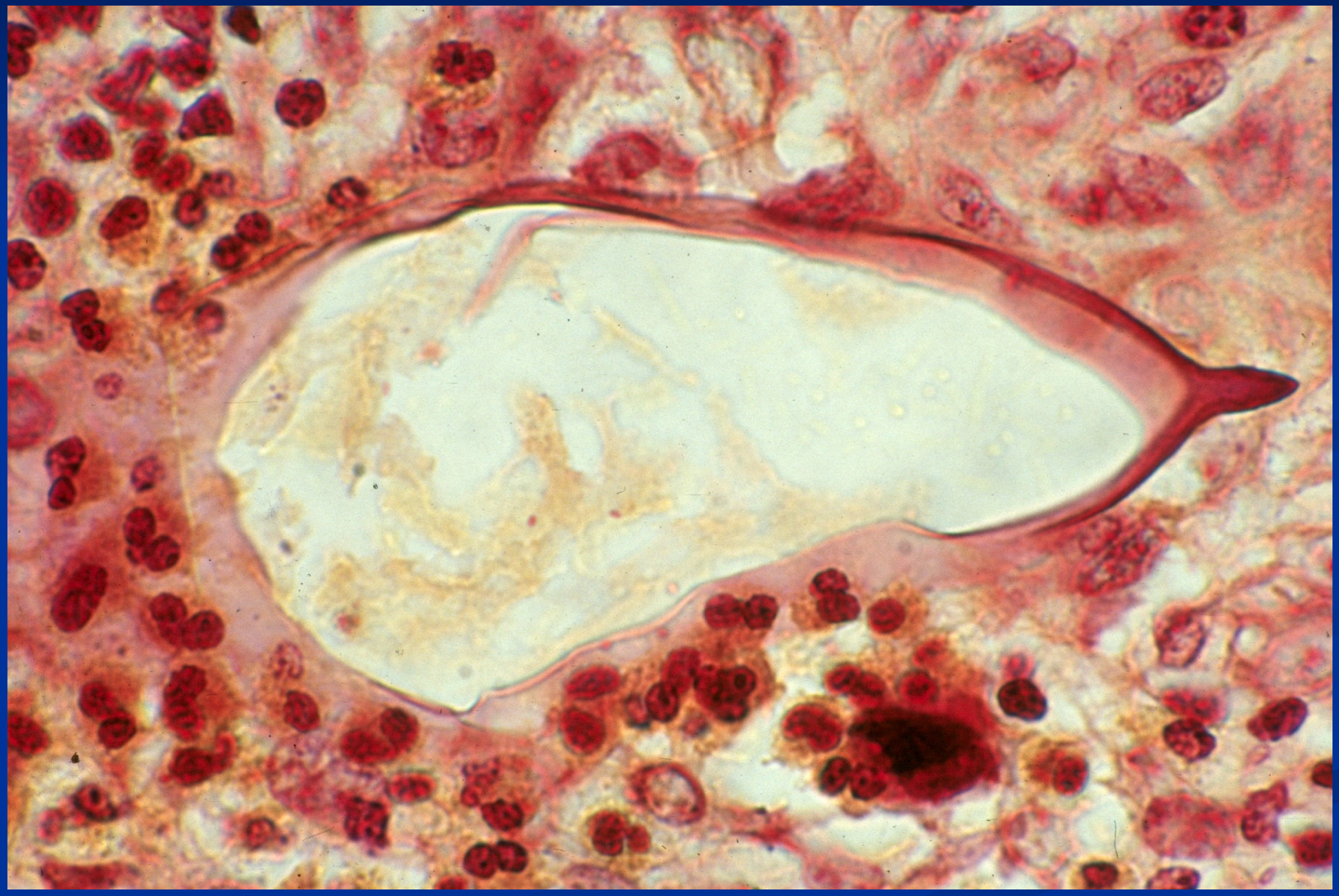
- Granuloma formation around eggs is primary cause of most disease associated with chronic schistosomiasis

- Eggs can embolize to other locations: lungs, CNS

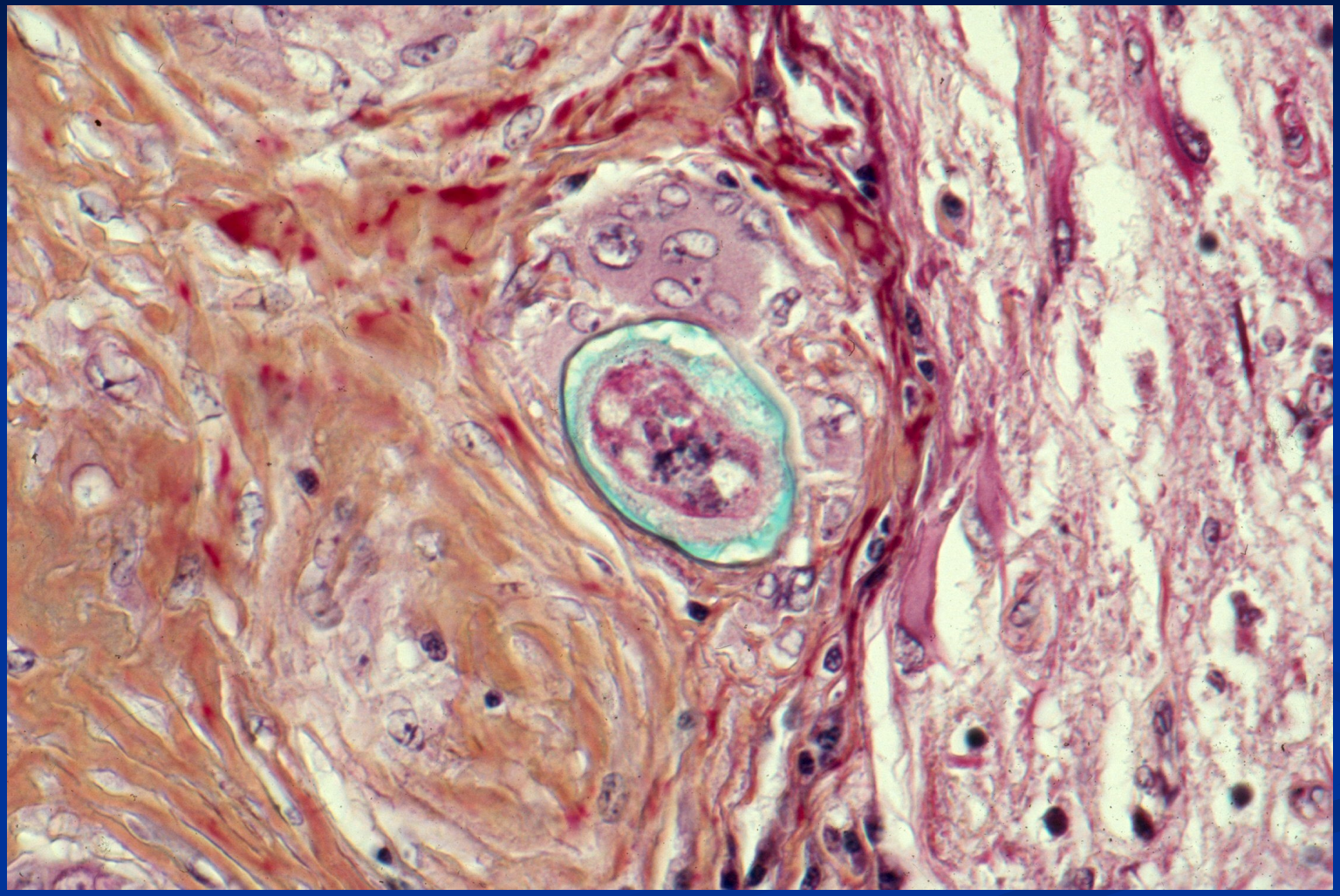
Colon (50x H&E)



Appendix (250x B&H)



Brain (400 x Movat)



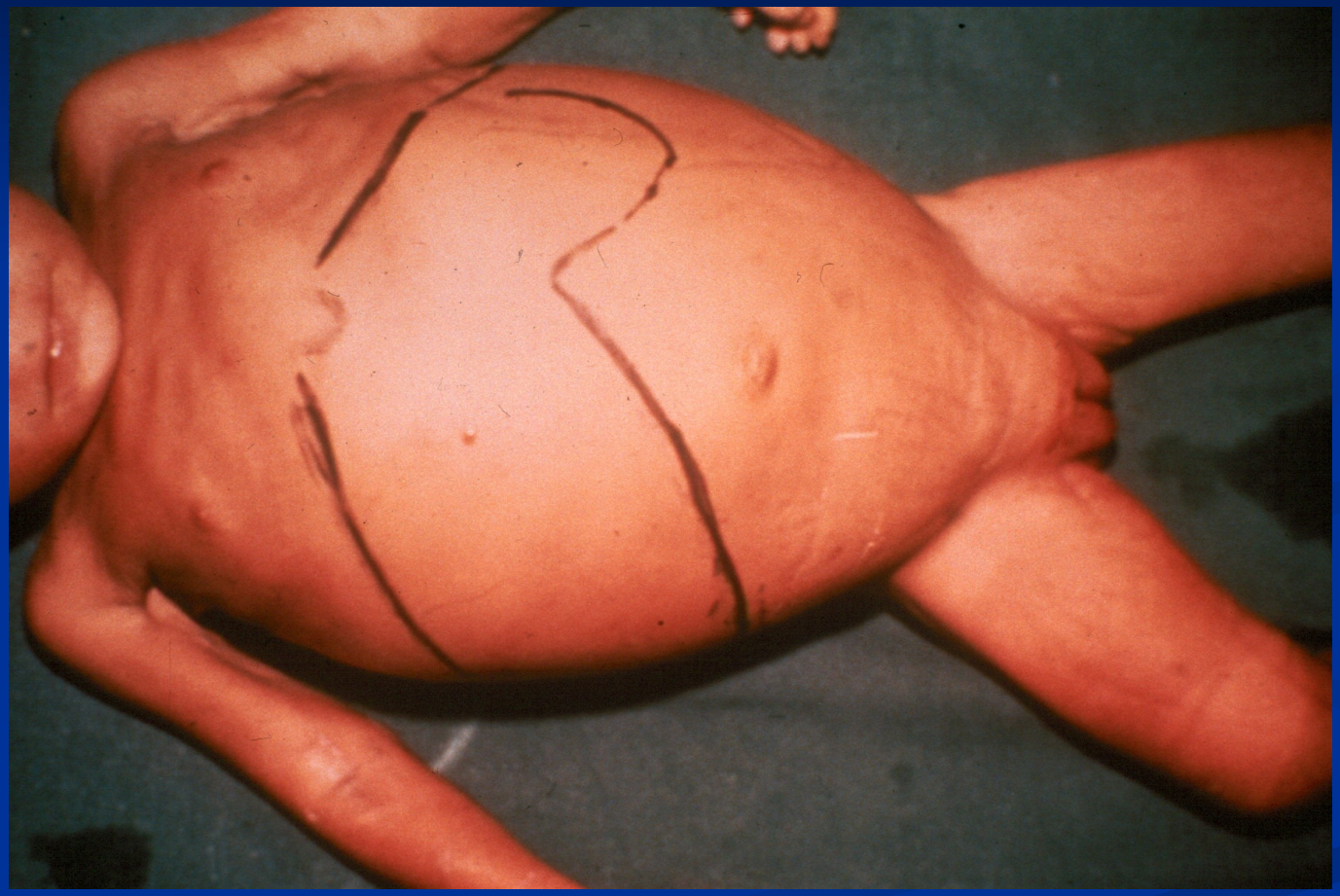
Clinical – Acute Stage

- Katayama Syndrome
  - IP 4-7 wks, during time of first egg release and formation of immune complexes
  - Immunologically naïve patients
  - Sudden onset of fever, chills, weakness, weight loss, headache, anorexia, nausea, vomiting, diarrhea, abdominal pain, tenesmus, myalgia, arthralgia, dry cough, hepatomegaly, eosinophilia (10,000/ul)

Clinical – Chronic Stage
S. mansoni & *S. japonicum*

- May not become patent for decades
- Signs & symptoms of focal granulomatous large bowel disease
- Abdominal pain, bloody stool, malaise
- Hepato & splenomegaly
- Portal hypertension, ascites
- Esophageal varices
- Intestinal granulomatosis & polyposis (*Sm*) in small portion of Middle Eastern patients

Hepatomegaly



Hepato & splenomegaly from *Sm*

Clinical – Chronic Stage
S. haematobium

- Dysuria, terminal hematuria, urinary frequency
- Obstructive uropathy
  - Pyelonephritis, renal failure
- Chronic bacteriuria
- Bladder carcinoma
- Calcification

Treatment

- Praziquantel is treatment of choice
  - 20 mg/kg po bid x 1d
- Metrifonate sometimes used against *S. haematobium* – 10 mg/kg po q2 wks x 3
- For praziquantel resistant *S. mansoni*
  - Oxaminiquine15 mg/kg po
  - N&E Africa – 20 mg/kg po x 3d

Diagnosis

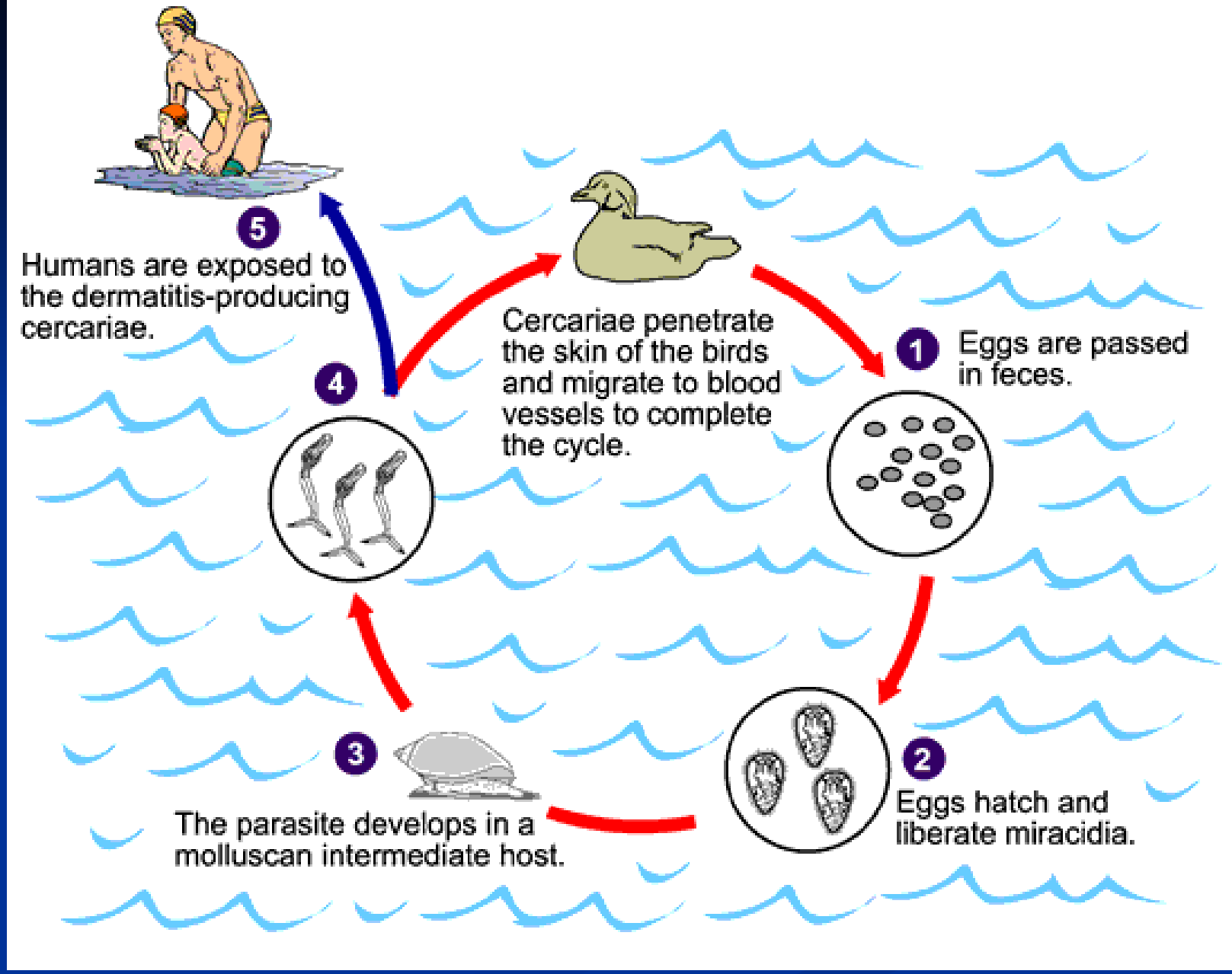
- ID of eggs in stool or urine
  - Quantification & viability
    - Kato thick smear – 50 mg feces squashed through 105 mesh steel sieve onto slide, covered w/ glycerin impregnated cover slip, 1-2 days fecal material will clear leaving eggs.
- ELISA, Immunoblot Ab detection tests
- Ag detection and rapids – dipstick assays against circulating antigens (CCA)

Prevention & Control

- Public education
- Keep feces & urine away from public use bodies of water or
- Separate water used for drinking, bathing or treat with iodine, chlorine or filtration
- Keep irrigation ditches free of snail intermediate hosts – clearing, molluscicides
- Mass chemotherapy campaigns

Cercarial dermatitis
Swimmer's Itch

- Skin penetration by cercaria, usually of zoophilic origin, esp. avian forms
- Sensitization reaction, increased severity with increased exposure
- Pruritic urticarial rash with onset ranging from minutes (repeated exposure) to days
- Lasts several days to few weeks
- Macular, papular, vesicular, pustular stages
- Treatment palliative


5
Humans are exposed to the dermatitis-producing cercariae.
4
Cercariae penetrate the skin of the birds and migrate to blood vessels to complete the cycle.
1
Eggs are passed in feces.
3
The parasite develops in a molluscan intermediate host.
2
Eggs hatch and liberate miracidia.

Swimmer’s Itch

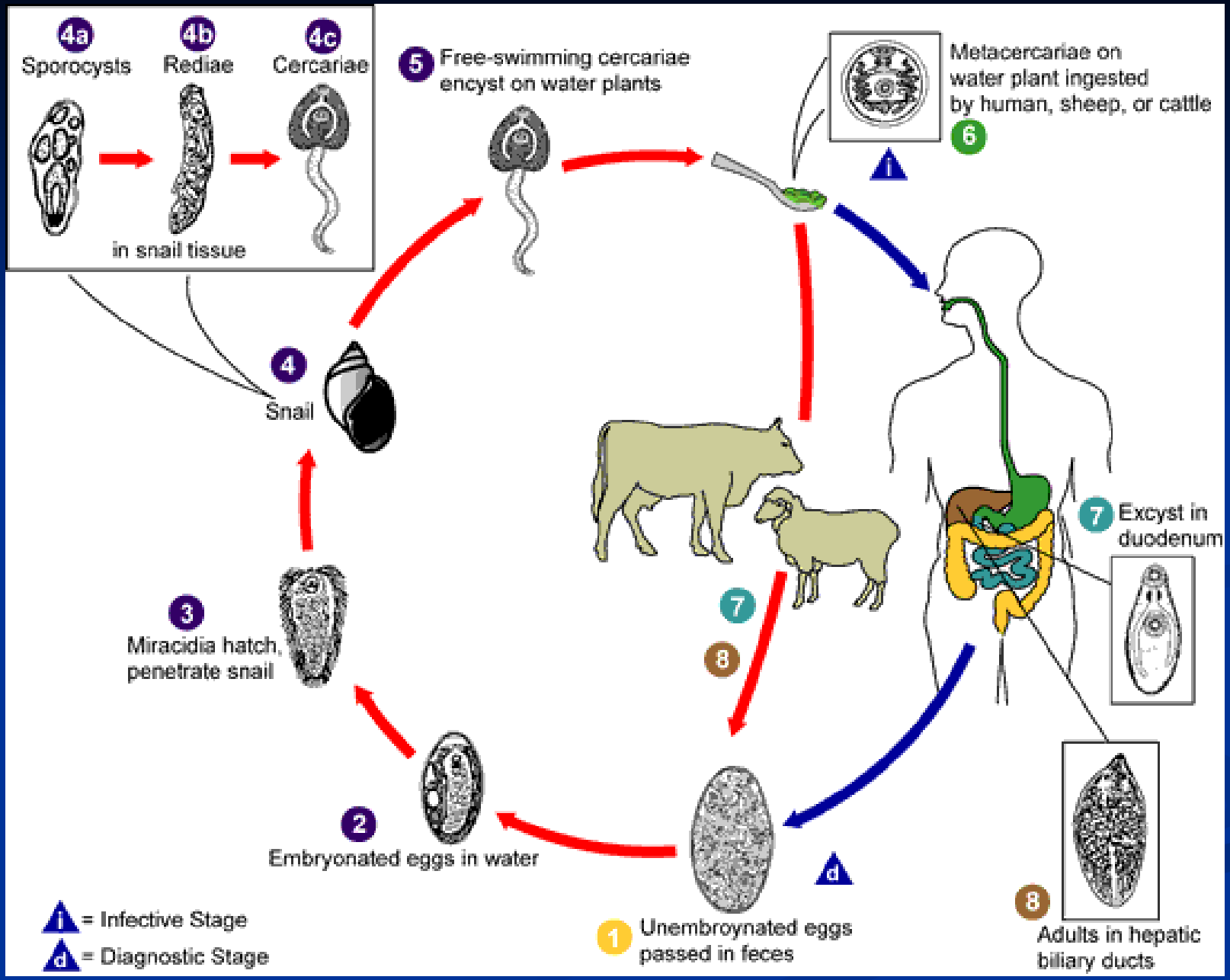
By Johnell Kolve, Image # Swimmer_Itch_1_031127; in DermAtlas.org

Fascioliasis

- *Fasciola hepatica* - Sheep liver fluke
- Worldwide, very common in herbivores
- Acquired from ingestion of watercress containing infective larvae (metacercaria)
- 2 million people infected

Fasciola Life Cycle

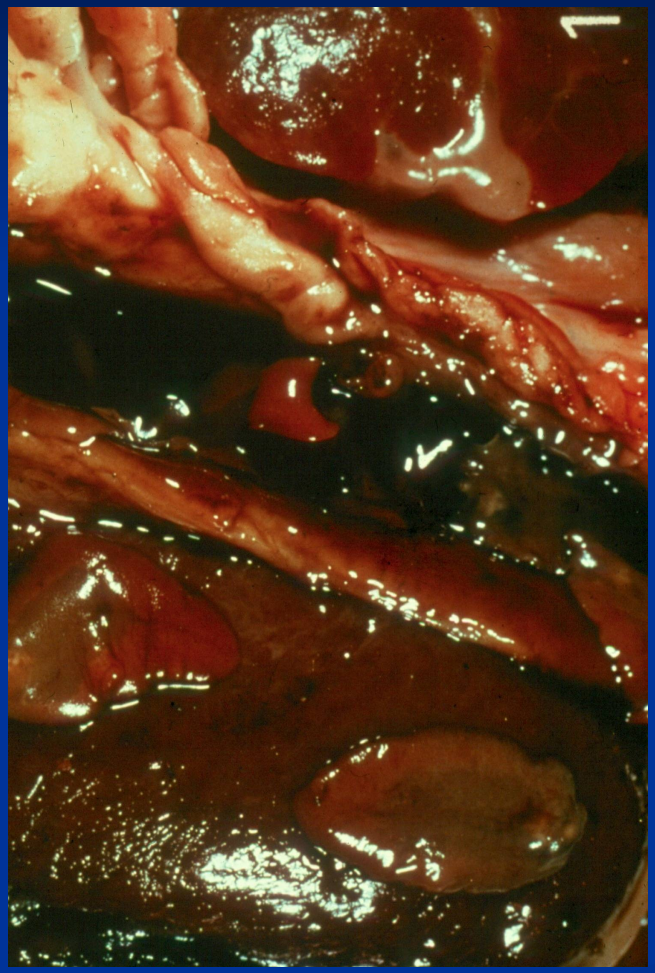
- Eggs shed in feces, miracidia hatch & invade snail intermediate host
- Develop to cercaria & are released into water, encyst on vegetation
- Eaten by definitive host (human or sheep), penetrate abdominal cavity, move into liver parenchyma to bile ducts, mature, produce eggs
- PP 3-4 months


4a
Sporocysts
4b
Rediae
4c
Cercariae
in snail tissue
5 Free-swimming cercariae encyst on water plants
Metacercariae on water plant ingested by human, sheep, or cattle
6
i
4
Snail
3
Miracidia hatch, penetrate snail
7
8
7 Excyst in duodenum
2
Embryonated eggs in water
d
1 Unembroynated eggs passed in feces
8
Adults in hepatic biliary ducts
i = Infective Stage
d = Diagnostic Stage

Fasciola Morphology

- Adults
  - 20-30 x 8-13 mm
  - Cephalic cone
- Eggs
  - Operculate
  - 130-150 x 60-100 µm

F. hepatica adults



Fasciolid egg

Fascioliasis

- Pathology related to worm burden
- Hyperplasia & necrosis, dilation, periductal fibrosis
- Mechanical obstruction leads to cholangitis, cholecystitis, cholelithiasis
- Acute stage (migration)
  - Fever, headache, anorexia, nausea, vomiting, RUQ & epigrastic pain, liver enlargement & tenderness, high eosinophilia
- Chronic stage
  - Pain, hepatomegaly, dyspepsia, diarrhea, nausea, vomiting, jaundice
- Ectopic locations common
  - Abscesses, necrosis, fibrosis

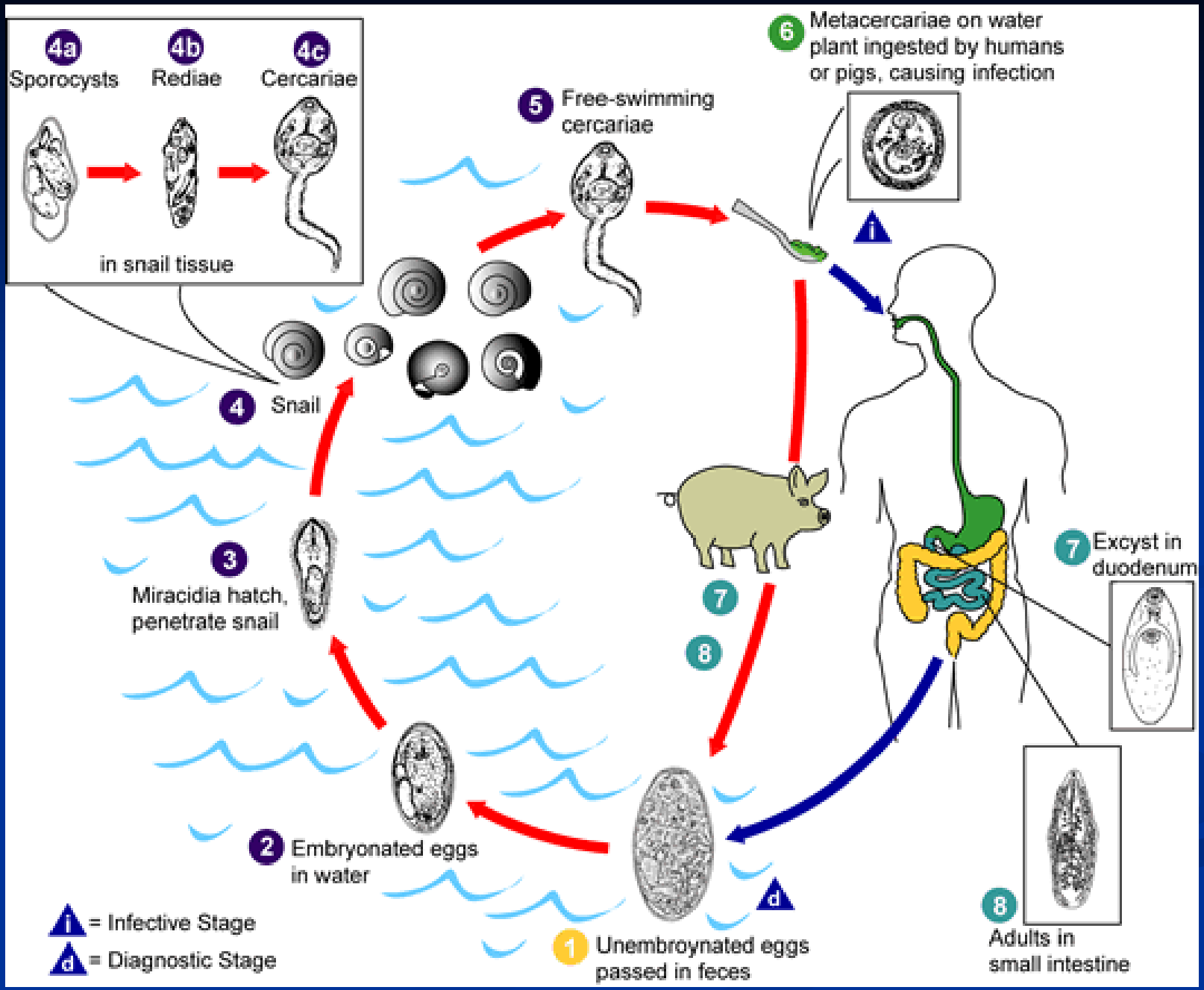
Fascioliasis Dx & Tx

- Eggs in stool, duodenal or biliary fluid
- Must differentiate from eggs acquired by ingestion of infected liver – eggs will merely pass through gut & be passed in stool

- Bithionol 30-40 mg/kg qod x 10-15 doses

Fasciolopsiasis

- *Fasciolopsis buski* – largest human fluke
- Far East, Southeast Asia
- Acquired by ingestion of metacercaria encysted on water vegetation, esp. water caltrops & chestnuts
- Reservoir in pigs
- Adults 20-75 x 0.5-3 mm w/ no cephalic cone
- Eggs indistinguishable from *F. hepatica*


4a
Sporocysts
4b
Rediae
4c
Cercariae
in snail tissue
5
Free-swimming cercariae
6
Metacercariae on water plant ingested by humans or pigs, causing infection
i
4
Snail
3
Miracidia hatch, penetrate snail
7
Excyst in duodenum
7
8
2
Embryonated eggs in water
d
1
Unembroynated eggs passed in feces
8
Adults in small intestine
i = Infective Stage
d = Diagnostic Stage

F. buski adult & egg

Fasciolopsiasis

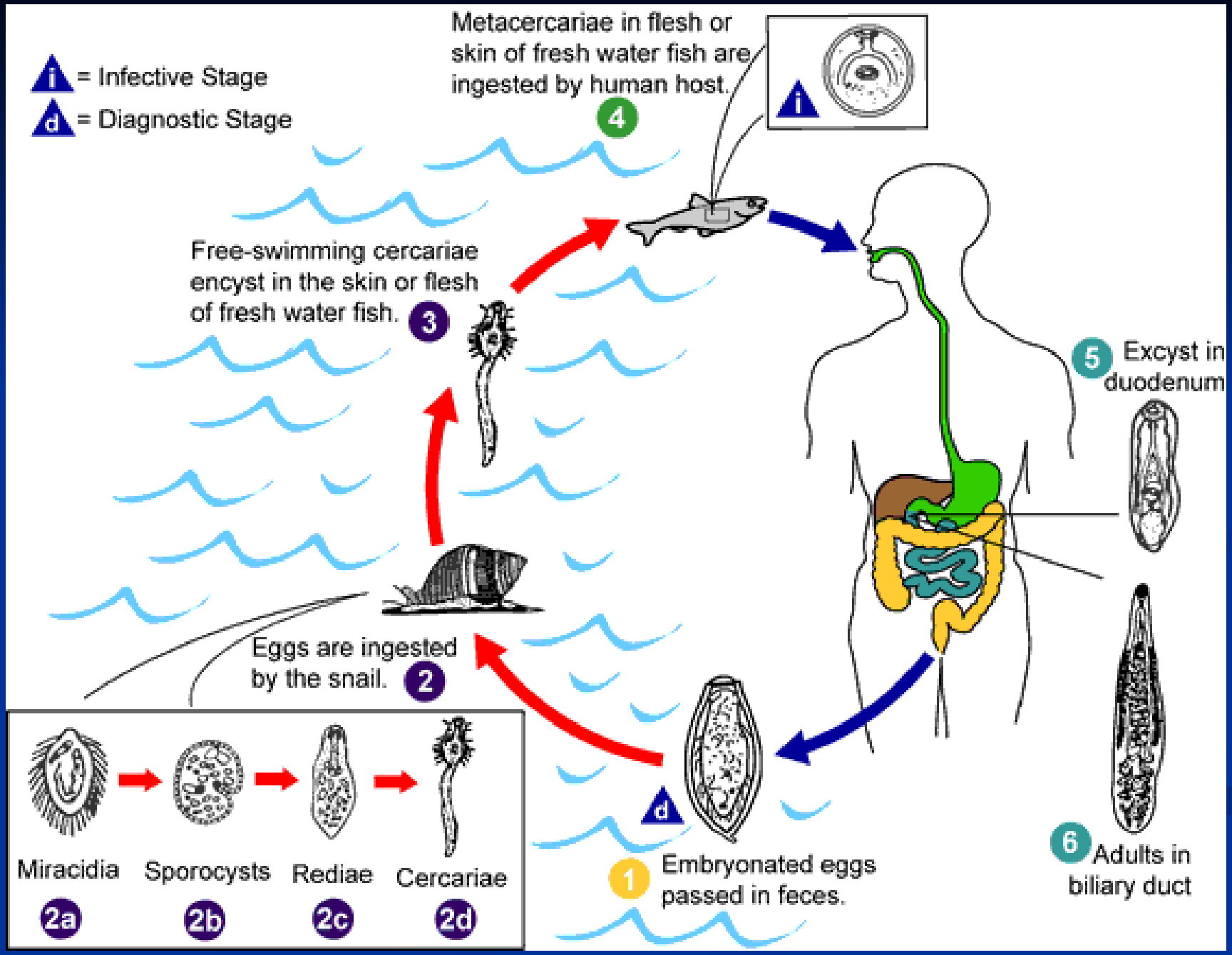
- Adults in duodenum & jejunum
- Obstruction causes diarrhea, constipation, anorexia, nausea, vomiting, edema
- Heavy infections can cause erosion & ulceration
- Eosinophilia common
- Dx via eggs in stool
- Tx w/ Praziquantel25 mg/kg po tid x 1d

Clonorchis sinensis, Opisthorchis viverrini & O. felineus

- Liver flukes
- China, Korea, Taiwan, SE Asia
- O. felineus in Europe, Siberia, Far East, 1.6 million infected
- 7 million people infected – *C. sinensis*
- 10 million with *O. viverrini*
- Reservoir in fish-eating mammals
- Acquired by ingestion of metacercaria encysted in freshwater fish

Life Cycle

- Eggs passed via feces into water
- Miracidium hatches & invades snail, develops to cercaria
- Cercaria released & invades fish, encyst to metacercaria
- Fish is eaten, metacercaria enters bile ducts, matures, produces eggs
- PP 4-6 wks


i = Infective Stage
d = Diagnostic Stage
Metacercariae in flesh or skin of fresh water fish are ingested by human host.
4
i
Free-swimming cercariae encyst in the skin or flesh of fresh water fish.
3
5 Excyst in duodenum
Eggs are ingested by the snail.
2
Miracidia
Sporocysts
Rediae
Cercariae
2a
2b
2c
2d
d
1 Embryonated eggs passed in feces.
6 Adults in biliary duct

Organisms

- Adult
  - 10-25 x 3-5 mm
  - Paired tandem testes
  - Quite attractive
- Eggs, both species similar
  - Shouldered operculum
  - 20-30 x 15-17 µm
  - Abopercular knob

Adults & egg

Clonorchis sinensis

Opisthorchis viverrini

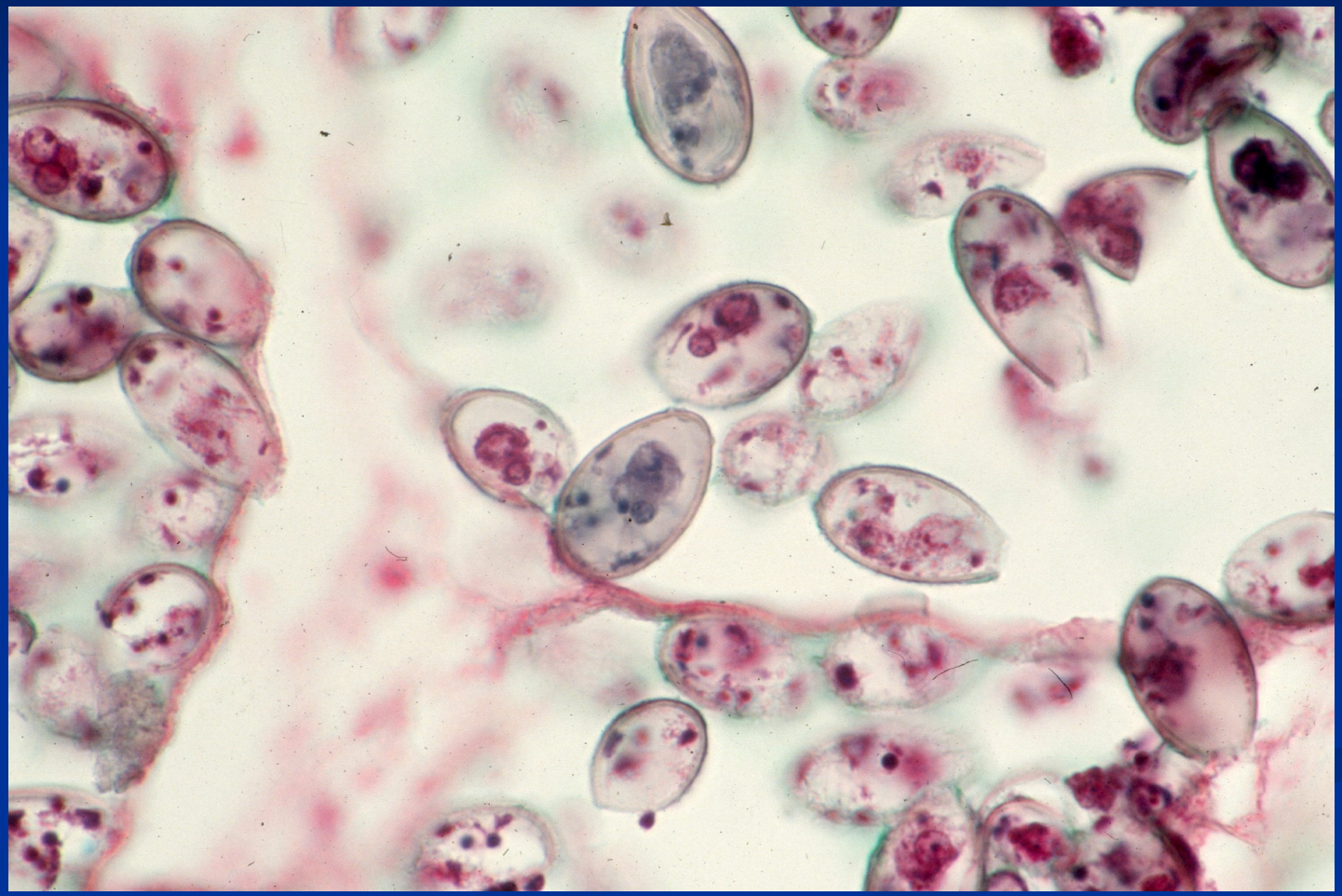
Egg

Clonorchiasis, Opisthorciasis

- Mechanical & toxic irritation
- Duct thickening & dilation, gallbladder enlargement
- Fibrosis, cirrhosis, granuloma formation
- Acute
  - Fever, anorexia, enlarged liver, hepatic & epigastric pain, eosinophilia
- Chronic
  - Hepatomegaly, epigastric & RUQ pain, gallbladder dilation & dysfuntion, weakness, anorexia, diarrhea
  - Cholelithiasis, pyogenic cholangitis, biliary obstruction, abscess & granuloma formation

Clonorchis in liver

Clonorchis eggs in tissue



Clonorchiasis Dx & Tx

- Eggs in stool
- Ultrasound, liver scans
- Serology not readily available

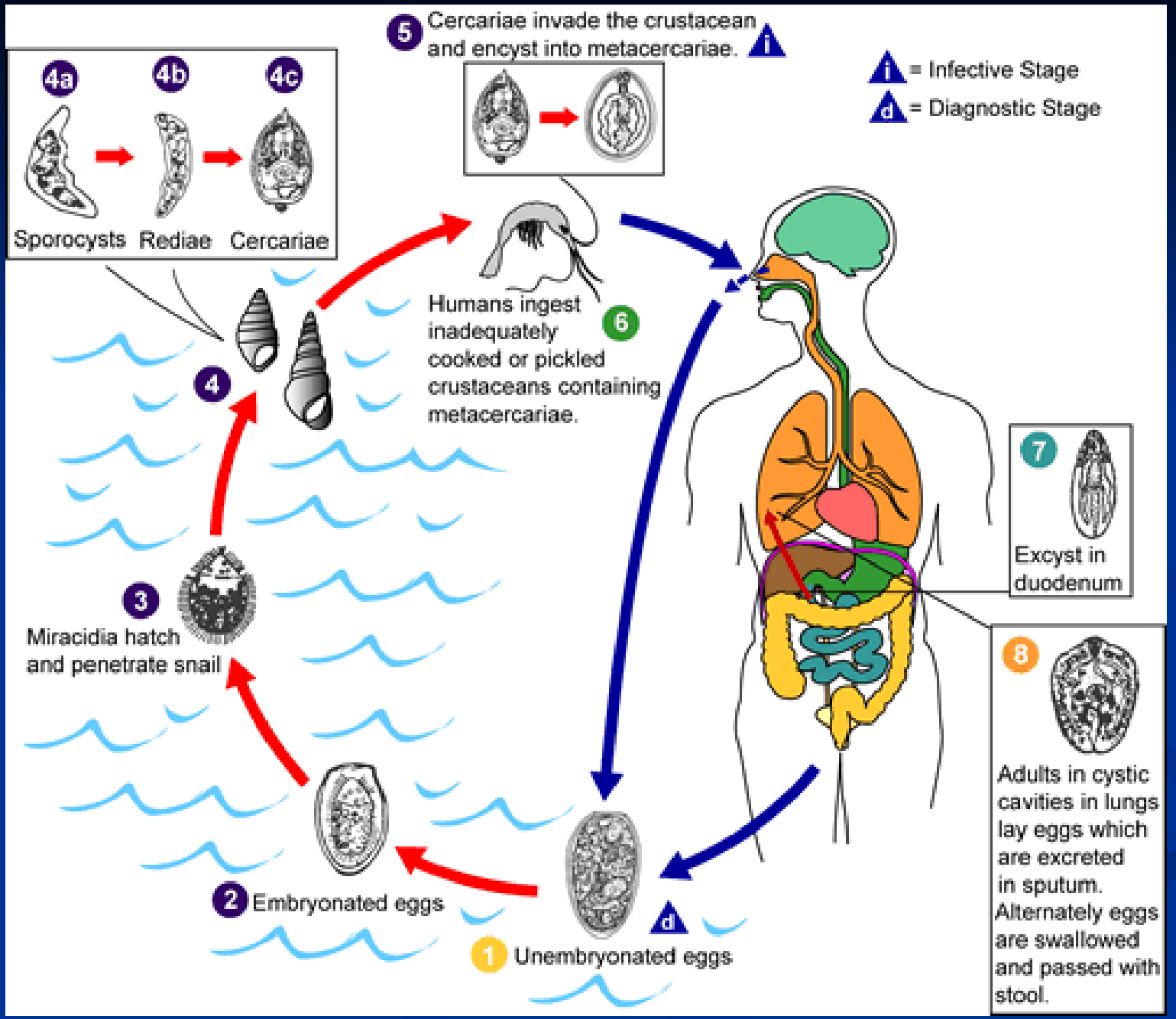
- Praziquantel 25 mg/kg po tid x 1d

Paragonimus westermani

- Oriental lung fluke
- Far East, Southeast Asia
  - Africa - *P. africanus* & *P. uterobilateralis*
  - C&S America – *P. mexicanus*
- 21 million infected
- Acquired from ingesting metacercaria encysted in raw or poorly cooked crabs & crayfish (jumping salad, drunken crab)

Paragonimus Life Cycle

- Eggs shed via sputum or feces into water, miracidium hatches & infects snail, develops into cercaria
- Cercaria released from snail, enters crustacean, encyst as metacercaria in gills, viscera & muscles
- Crustacean eaten, metacercaria pass into abdominal cavity, through diaphragm, penetrate lungs, mature in host-induced capsule (usually in pairs)
- PP 8-10 wks


5 Cercariae invade the crustacean and encyst into metacercariae.
i = Infective Stage
d = Diagnostic Stage
4a
4b
4c
Sporocysts
Rediae
Cercariae
Humans ingest inadequately cooked or pickled crustaceans containing metacercariae.
6
4
3
Miracidia hatch and penetrate snail
2 Embryonated eggs
1 Unembryonated eggs
d
7
Excyst in duodenum
8
Adults in cystic cavities in lungs lay eggs which are excreted in sputum. Alternately eggs are swallowed and passed with stool.

P. westermani Morphology

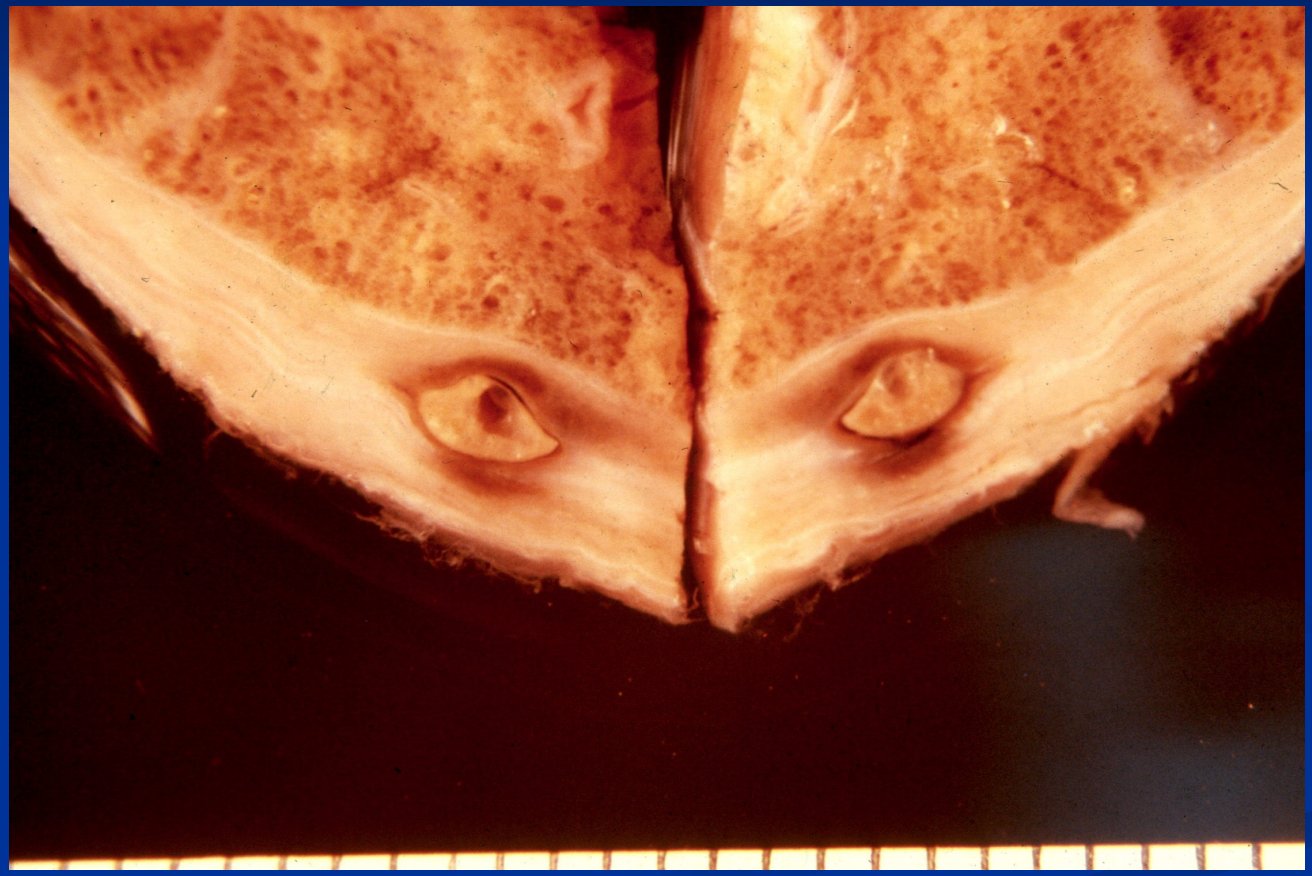
- Adults
  - Found in lungs
  - 8-16 x 4-8 mm
  - Vase shaped
- Eggs
  - 80-120 x 50-65 um
  - Operculate
  - Abopercular thickening
  - “Top-heavy”

P. westermani adult & egg

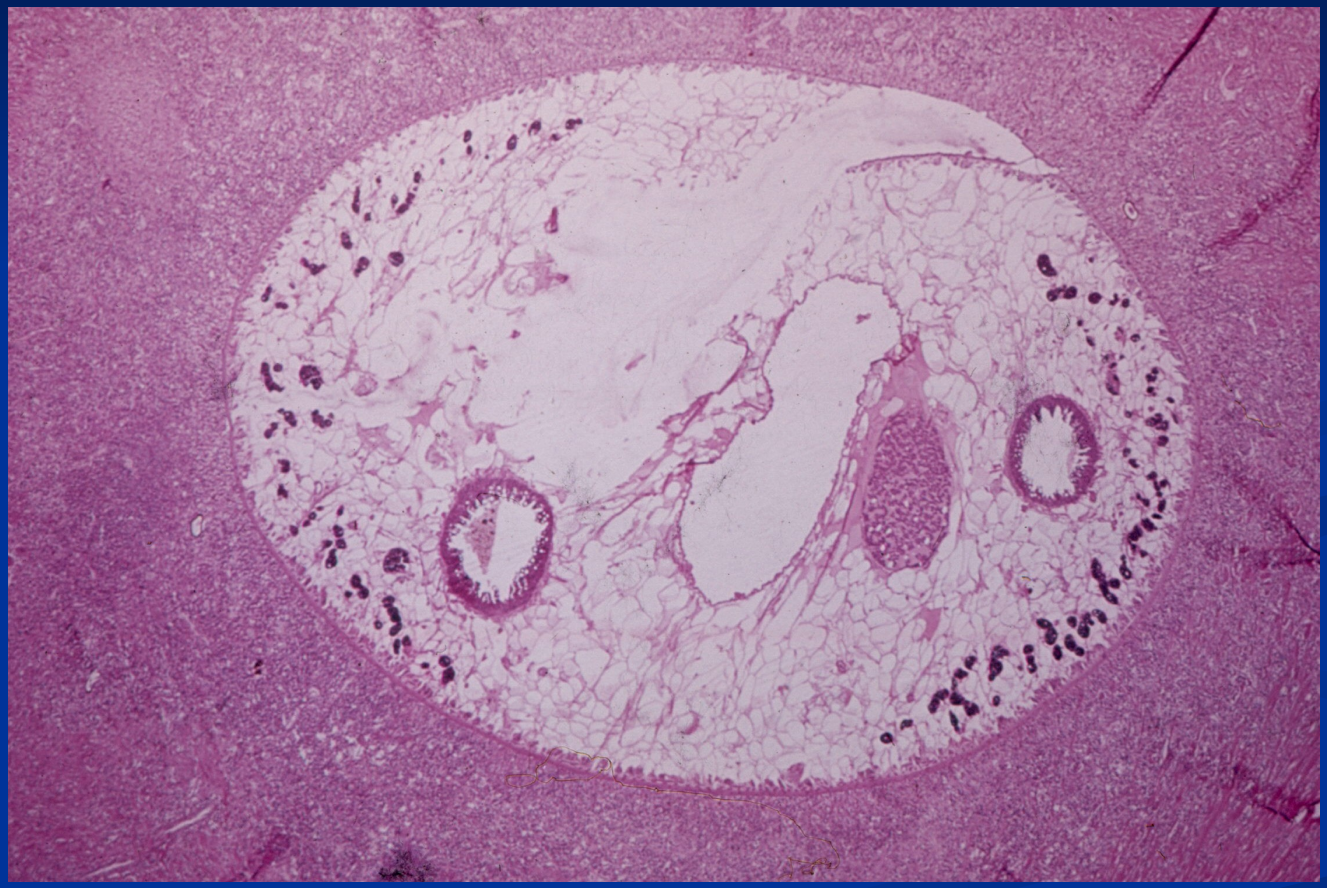
Paragonimiasis

- Lesions from adults, eggs, secreted substances
- Inflammatory rxn around adult induces capsule formation, 1-2 cm cysts
- Necrotic debris, eggs, Charcot-Leyden crystals in sputum when cysts rupture
- Ectopic locations common – CNS, liver, abdominal cavity, skin, pericardium, heart

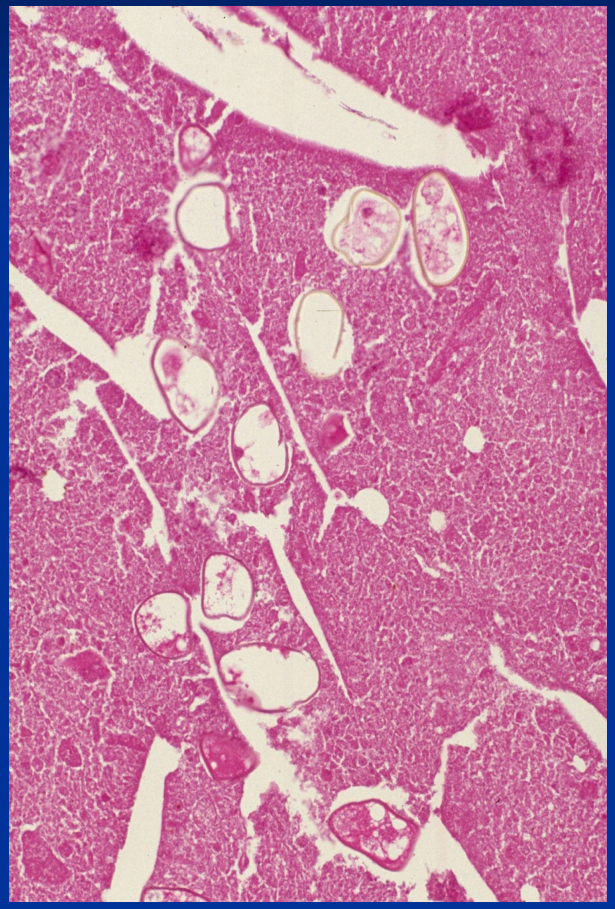
Adult in pleura

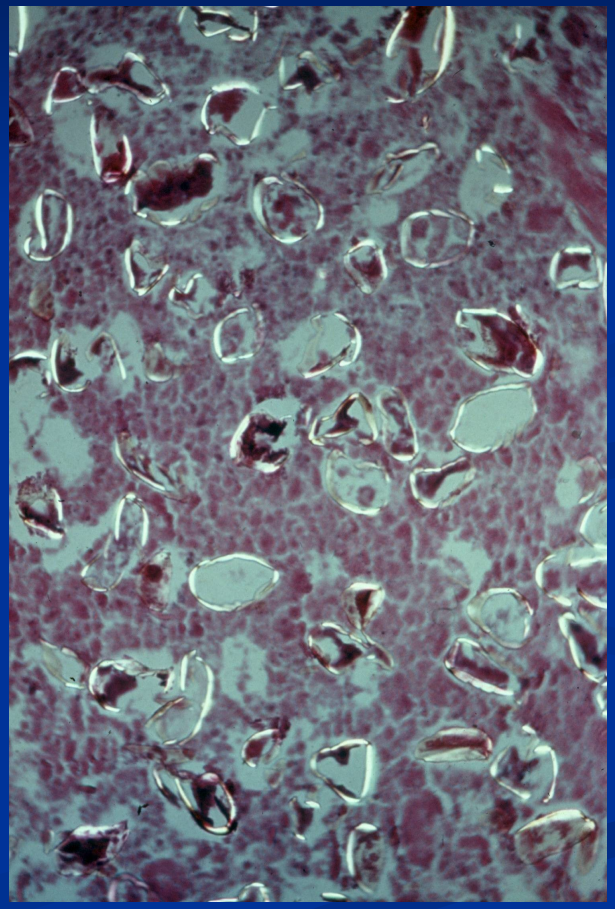


Adult in capsule, xs



Paragonimus in omentum





Paragonimiasis

- Acute disease
  - Fever, chills, chest & abdominal pain, urticaria, eosinophilia, cough, dyspnea, night sweats
- Chronic
  - Resembles chronic bronchitis
  - Paroxysmal cough, hemoptysis, iron-filing sputum, chest pain, weight loss, [illegible]ss
  - Expectorate 25 ml/d

Paragonimiasis Dx & Tx

- Eggs in feces, sputum, pleural fluid
- Radiology – ring shadow w/ crescent-shaped opacity
- CF, CIE, ELISA

- Praziquantel 25 mg/kg po tid x 2d